

IN THE CLAIMS:

Please amend claims 1, 3, 4, 5, 9, 11, 12, 13, 17, 19, 20, and 21, and please cancel claims 2, 10, 18, and 37-40, as set forth below.

1 1. (Currently Amended) A thermal management system for an integrated
2 circuit die comprising:
3 a temperature detection element formed directly on the integrated circuit die, the
4 temperature detection element including at least one temperature sensor having an
5 output, the at least one temperature sensor including[[:]]
6 a reference voltage source providing a reference voltage,
7 a programmable voltage source providing a programmable voltage proportional to
8 a temperature of the integrated circuit die, and
9 a comparator having one input coupled via a first signal line to the reference
10 voltage source and another input coupled via a second signal line to the
11 programmable voltage source, the comparator to provide a signal at the
12 output of the at least one temperature sensor in response to the
13 programmable voltage substantially equaling the reference voltage;
14 a power modulation element formed directly on the integrated circuit die, the power
15 modulation element to reduce power consumption of the integrated circuit die in
16 response to the output of the at least one temperature sensor;
17 a control element formed directly on the integrated circuit die, the control element
18 including at least one register to provide an enable/disable bit for the thermal
19 management system; and
20 a visibility element formed directly on the integrated circuit die, the visibility element to
21 indicate a status of the output of the at least one temperature sensor.

2. (Canceled)

1 3. (Currently Amended) The system of ~~claim 2~~ claim 1, further comprising a
2 pulse dampener coupled to the first signal line, the pulse dampener to at least partially
3 remove electrical noise from the reference voltage.

1 4. (Currently Amended) The system of ~~claim 2~~ claim 1, further comprising
2 an analog filter coupled to the second signal line and the first signal line, the analog filter
3 to detect voltage spikes present in the reference voltage and to add substantially identical
4 voltage spikes to the programmable voltage.

1 5. (Currently Amended) The system of ~~claim 2~~ claim 1, further comprising a
2 digital filter coupled to an output of the comparator, the digital filter including an up-
3 down counter to count clock pulses, the up-down counter to increment once for each
4 clock pulse detected when the comparator output is at a first state and to decrement once
5 for each clock pulse detected when the comparator output is at a second state.

1 6. (Previously Presented) The system of claim 1, the control element further
2 including at least one of a register to selectively disengage a specified portion of the
3 thermal management system, a register to enable the thermal management system in
4 response to an occurrence of an external event, a register to force the thermal
5 management system active while overriding a disable bit provided by the at least one
6 register, and a register to allow external software and hardware to enable the thermal
7 management system.

1 7. (Previously Presented) The system of claim 1, the visibility element
2 including at least one of a register to indicate the status of the temperature sensor output,
3 a register to provide a sticky bit, a counter to count a number of lost clock cycles
4 resulting from operation of the thermal management system, and circuitry to generate an
5 interrupt when the output of the at least one temperature sensor transitions to a different
6 state.

1 8. (Previously Presented) The system of claim 1, the power modulation
2 element to reduce the power consumption of the integrated circuit die by performing at
3 least one of lowering a supply voltage to the integrated circuit die, lowering a frequency
4 of a clock signal provided by internal clock circuitry on the integrated circuit die,
5 performing clock gating of the clock signal provided by the internal clock circuitry,
6 performing clock throttling of the clock signal provided by the internal clock circuitry,
7 selectively blocking clock pulses of the clock signal provided by the internal clock
8 circuitry, disabling at least one of a plurality of functional units on the integrated circuit
9 die, limiting instructions sent to at least one of the plurality of functional units on the
10 integrated circuit die, and changing a behavior of at least one of the plurality of functional
11 units on the integrated circuit die.

1 9. (Currently Amended) A microprocessor comprising:
2 a die having a plurality of functional units formed thereon;
3 internal clock circuitry formed on the die and coupled to at least one of the plurality of
4 functional units; and
5 a thermal management system formed directly on the die, the thermal management
6 system including
7 a temperature detection element including at least one temperature sensor having
8 an output, the at least one temperature sensor including[[]]
9 a reference voltage source providing a reference voltage,
10 a programmable voltage source providing a programmable voltage
11 proportional to a temperature of the die, and
12 a comparator having one input coupled via a first signal line to the
13 reference voltage source and another input coupled via a second
14 signal line to the programmable voltage source, the comparator to
15 provide a signal at the output of the at least one temperature sensor
16 in response to the programmable voltage substantially equaling the
17 reference voltage;
18 a power modulation element to reduce power consumption of at least one of the
19 functional units in response to the output of the at least one temperature
20 sensor;
21 a control element including at least one register to provide an enable/disable bit
22 for the thermal management system; and
23 a visibility element to indicate a status of the output of the at least one
24 temperature sensor.

10. (Canceled)

1 11. (Currently Amended) The microprocessor of ~~claim 10~~ claim 9, further
2 comprising a pulse dampener coupled to the first signal line, the pulse dampener to at
3 least partially remove electrical noise from the reference voltage.

1 12. (Currently Amended) The microprocessor of ~~claim 10~~ claim 9, further
2 comprising an analog filter coupled to the second signal line and the first signal line, the
3 analog filter to detect voltage spikes present in the reference voltage and to add
4 substantially identical voltage spikes to the programmable voltage.

1 13. (Currently Amended) The microprocessor of ~~claim 10~~ claim 9, further
2 comprising a digital filter coupled to an output of the comparator, the digital filter
3 including an up-down counter to count clock pulses, the up-down counter to increment
4 once for each clock pulse detected when the comparator output is at a first state and to
5 decrement once for each clock pulse detected when the comparator output is at a second
6 state.

1 14. (Previously Presented) The microprocessor of claim 9, the control
2 element further including at least one of a register to selectively disengage a specified
3 portion of the thermal management system, a register to enable the thermal management
4 system in response to an occurrence of an external event, a register to force the thermal
5 management system active while overriding a disable bit provided by the at least one
6 register, and a register to allow external software and hardware to enable the thermal
7 management system.

1 15. (Previously Presented) The microprocessor of claim 9, the visibility
2 element including at least one of a register to indicate the status of the temperature sensor
3 output, a register to provide a sticky bit, a counter to count a number of lost clock cycles
4 resulting from operation of the thermal management system, and circuitry to generate an
5 interrupt when the output of the at least one temperature sensor transitions to a different
6 state.

1 16. (Previously Presented) The microprocessor of claim 9, the power
2 modulation element to reduce the power consumption of the at least one functional unit
3 by performing at least one of lowering a supply voltage to the die, lowering a frequency
4 of a clock signal provided by the internal clock circuitry, performing clock gating of the
5 clock signal provided by the internal clock circuitry, performing clock throttling of the
6 clock signal provided by the internal clock circuitry, selectively blocking clock pulses of
7 the clock signal provided by the internal clock circuitry, disabling at least one of the
8 plurality of functional units on the die, limiting instructions sent to at least one of the
9 plurality of functional units on the die, and changing a behavior of at least one of the
10 plurality of functional units on the die.

1 17. (Currently Amended) A computer system comprising:
2 at least one memory device coupled to a bus; and
3 at least one microprocessor coupled to the bus, the at least one microprocessor including
4 a die having a plurality of functional units formed thereon;
5 internal clock circuitry formed on the die and coupled to at least one of the
6 plurality of functional units; and
7 a thermal management system located on the die, the thermal management system
8 including
9 a temperature detection element formed directly on the die, the
10 temperature detection element including at least one temperature
11 sensor having an output, the at least one temperature sensor
12 including[;]
13 a reference voltage source providing a reference voltage,
14 a programmable voltage source providing a programmable voltage
15 proportional to a temperature of the die, and
16 a comparator having one input coupled via a first signal line to the
17 reference voltage source and another input coupled via a
18 second signal line to the programmable voltage source, the
19 comparator to provide a signal at the output of the at least
20 one temperature sensor in response to the programmable
21 voltage substantially equaling the reference voltage;
22 a power modulation element formed directly on the die, the power
23 modulation element to reduce power consumption of at least one of
24 the functional units in response to the output of the at least one
25 temperature sensor;
26 a control element formed directly on the die, the control element including
27 at least one register to provide an enable/disable bit; and
28 a visibility element formed directly on the die, the visibility element to
29 indicate a status of the output of the at least one temperature
30 sensor.

18. (Canceled)

1 19. (Currently Amended) The computer system of ~~claim 18~~ claim 17, further
2 comprising a pulse dampener coupled to the first signal line, the pulse dampener to at
3 least partially remove electrical noise from the reference voltage.

1 20. (Currently Amended) The computer system of ~~claim 18~~ claim 17, further
2 comprising an analog filter coupled to the second signal line and the first signal line, the
3 analog filter to detect voltage spikes present in the reference voltage and to add
4 substantially identical voltage spikes to the programmable voltage.

1 21. (Currently Amended) The computer system of ~~claim 18~~ claim 17, further
2 comprising a digital filter coupled to an output of the comparator, the digital filter
3 including an up-down counter to count clock pulses, the up-down counter to increment
4 once for each clock pulse detected when the comparator output is at a first state and to
5 decrement once for each clock pulse detected when the comparator output is at a second
6 state.

1 22. (Previously Presented) The computer system of claim 17, the control
2 element further including at least one of a register to selectively disengage a specified
3 portion of the thermal management system, a register to enable the thermal management
4 system in response to an occurrence of an external event, a register to force the thermal
5 management system active while overriding a disable bit provided by the at least one
6 register, and a register to allow external software and hardware to enable the thermal
7 management system.

1 23. (Previously Presented) The computer system of claim 17, the visibility
2 element including at least one of a register to indicate the status of the temperature sensor
3 output, a register to provide a sticky bit, a counter to count a number of lost clock cycles
4 resulting from operation of the thermal management system, and circuitry to generate an
5 interrupt when the output of the at least one temperature sensor transitions to a different
6 state.

1 24. (Previously Presented) The computer system of claim 17, the power
2 modulation element to reduce the power consumption of the at least one functional unit
3 by performing at least one of lowering a supply voltage to the die, lowering a frequency
4 of a clock signal provided by the internal clock circuitry, performing clock gating of the
5 clock signal provided by the internal clock circuitry, performing clock throttling of the
6 clock signal provided by the internal clock circuitry, selectively blocking clock pulses of
7 the clock signal provided by the internal clock circuitry, disabling at least one of the
8 plurality of functional units on the die, limiting instructions sent to at least one of the
9 plurality of functional units on the die, and changing a behavior of at least one of the
10 plurality of functional units on the die.

1 25. (Previously Presented) A method comprising:
2 providing an enable bit to a register to activate a thermal management system of a die;
3 measuring a temperature on the die with a sensor of the thermal management system;
4 providing a first state at an output of the sensor when the temperature is below a trip
5 point;
6 providing a second state at the sensor output when the temperature equals or exceeds the
7 trip point;
8 in response to the sensor output having the second state, engaging a power reduction
9 mechanism for a specified time interval to reduce power consumption of the die;
10 polling the sensor output after expiration of the specified time interval;
11 if the sensor output exhibits the second state when polled, repeating the acts of engaging
12 the power reduction mechanism for the specified time interval and polling the
13 sensor output after expiration of the specified time interval; and
14 if the sensor output exhibits the first state when polled, halting the power reduction
15 mechanism.

1 26. (Previously Presented) The method of claim 25, further comprising
2 engaging the power reduction mechanism to perform at least one of lowering a supply
3 voltage to the die, lowering a frequency of a clock signal provided by internal clock
4 circuitry on the die, performing clock gating of the clock signal provided by the internal
5 clock circuitry, performing clock throttling of the clock signal provided by the internal
6 clock circuitry, selectively blocking clock pulses of the clock signal provided by the
7 internal clock circuitry, disabling at least one of a plurality of functional units on the die,
8 limiting instructions sent to at least one of the plurality of functional units on the die, and
9 changing a behavior of at least one of the plurality of functional units on the die.

1 27. (Previously Presented) The method of claim 25, further comprising
2 providing an enable bit to the register from an external operating system.

Claims 28-30 (Canceled)

1 31. (Previously Presented) The method of claim 25, further comprising:
2 incrementing an up-down counter coupled with the sensor output once for every clock
3 pulse of the clock signal provided by the internal clock circuitry when the sensor
4 output exhibits the first state; and
5 decrementing the up-down counter once for every clock pulse of the clock signal
6 provided by the internal clock circuitry when the sensor output exhibits the
7 second state.

1 32. (Previously Presented) The method of claim 25, further comprising:
2 defining a plurality of trip temperatures, a highest of the plurality of trip temperatures
3 corresponding to the trip point;
4 assigning a plurality of duty cycle values to the plurality of trip temperatures, one duty
5 cycle value of the plurality of duty cycle values corresponding to at least one of
6 the plurality of trip temperatures; and
7 providing a clock signal from internal clock circuitry on the die, the clock signal
8 exhibiting the one duty cycle value in response to the temperature substantially
9 equaling that at least one corresponding trip temperature.

1 33. (Previously Presented) The method of claim 25, further comprising
2 counting a number of lost clock cycles resulting from engagement of the power reduction
3 mechanism.

1 34. (Previously Presented) An apparatus comprising:
2 a temperature detection element, the temperature detection element including at least one
3 temperature sensor having an output;
4 a power modulation element, the power modulation element to reduce power
5 consumption of an integrated circuit die in response to the output of the at least
6 one temperature sensor;
7 a visibility element, the visibility element to indicate a status of the output of the at least
8 one temperature sensor, the visibility element including
9 a register to indicate the status of the output of the at least one temperature sensor;
10 a register providing a sticky bit;
11 a counter to count a number of lost clock cycles resulting from operation of the
12 apparatus; and
13 circuitry to generate an interrupt when the output of the at least one temperature
14 sensor transitions to a different state.

1 35. (Previously Presented) The apparatus of claim 34, further including a
2 control element, the control element comprising:
3 a register to provide an enable/disable bit for the apparatus;
4 a register to selectively disengage a specified portion of the apparatus;
5 a register to enable the apparatus in response to an occurrence of an external event;
6 a register to force the apparatus active while overriding a disable bit provided at the
7 enable/disable bit; and
8 a register to allow external software and hardware to enable the apparatus.

1 36. (Previously Presented) The system of claim 34, the power modulation
2 element to reduce the power consumption of the integrated circuit die by performing at
3 least one of lowering a supply voltage to the integrated circuit die, lowering a frequency
4 of a clock signal provided by internal clock circuitry on the integrated circuit die,
5 performing clock gating of the clock signal provided by the internal clock circuitry,
6 performing clock throttling of the clock signal provided by the internal clock circuitry,
7 selectively blocking clock pulses of the clock signal provided by the internal clock
8 circuitry, disabling at least one of a plurality of functional units on the integrated circuit
9 die, limiting instructions sent to at least one of the plurality of functional units on the
10 integrated circuit die, and changing a behavior of at least one of the plurality of functional
11 units on the integrated circuit die.

Claims 37-40 (Canceled)

1 41. (Withdrawn) An apparatus comprising:
2 a first register to provide an enable/disable bit for a thermal management system on an
3 integrated circuit die;
4 a second register to selectively disengage a specified portion of the thermal management
5 system;
6 a third register to enable the thermal management system in response to an external
7 event;
8 a fourth register to force the thermal management system active while overriding a
9 disable bit provided by the first register; and
10 a fifth register to allow external software and hardware to enable the thermal
11 management system.

1 42. (Withdrawn) The apparatus of claim 41, further comprising a visibility
2 element to indicate a status of an output of a temperature sensor associated with the
3 thermal management system.

1 43. (Withdrawn) The apparatus of claim 42, the visibility element
2 comprising:
3 a register to indicate the status of the temperature sensor output;
4 another register to provide a sticky bit;
5 a counter to count a number of lost clock cycles resulting from operation of the thermal
6 management system; and
7 circuitry to generate an interrupt when the temperature sensor output transitions to a
8 different state.

1 44. (Withdrawn) The apparatus of claim 42, further comprising a power
2 modulation element to reduce power consumption of the integrated circuit die in response
3 to the temperature sensor output.

1 45. (Withdrawn) An apparatus comprising:
2 a register to indicate a status of an output of a temperature sensor associated with a
3 thermal management system on an integrated circuit die;
4 another register to provide a sticky bit;
5 a counter to count a number of lost clock cycles resulting from operation of the thermal
6 management system; and
7 circuitry to generate an interrupt when the temperature sensor output transitions to a
8 different state.

1 46. (Withdrawn) The apparatus of claim 45, further comprising a control
2 element including a first register to provide an enable/disable bit for the thermal
3 management system.

1 47. (Withdrawn) The apparatus of claim 46, the control element further
2 comprising:
3 a second register to selectively disengage a specified portion of the thermal management
4 system;
5 a third register to enable the thermal management system in response to an external
6 event;
7 a fourth register to force the thermal management system active while overriding a
8 disable bit provided by the first register; and
9 a fifth register to allow external software and hardware to enable the thermal
10 management system.

1 48. (Withdrawn) The apparatus of claim 46, further comprising a power
2 modulation element to reduce power consumption of the integrated circuit die in response
3 to the temperature sensor output.

1 49. (Previously Presented) The method of claim 25, further comprising
2 providing an indication of a status of the sensor output to an external device.

1 50. (Withdrawn) A method comprising:
2 activating a thermal management system of a die;
3 measuring a temperature on the die with a sensor of the thermal management system;
4 providing a first state at an output of the sensor when the temperature is below a trip
5 point;
6 providing a second state at the sensor output when the temperature equals or exceeds the
7 trip point;
8 engaging a power reduction mechanism for a specified time period in response to the
9 sensor output having the second state;
10 polling the sensor output after expiration of the specified time period; and
11 halting the power reduction mechanism when the sensor output exhibits the first state.

1 51. (Withdrawn) The method of claim 50, further comprising engaging the
2 power reduction mechanism to perform at least one of lowering a supply voltage to the
3 die, lowering a frequency of a clock signal provided by internal clock circuitry on the die,
4 performing clock gating of the clock signal provided by the internal clock circuitry,
5 performing clock throttling of the clock signal provided by the internal clock circuitry,
6 selectively blocking clock pulses of the clock signal provided by the internal clock
7 circuitry, disabling at least one of a plurality of functional units on the die, limiting
8 instructions sent to at least one of the plurality of functional units on the die, and
9 changing a behavior of at least one of the plurality of functional units on the die.

1 52. (Withdrawn) The method of claim 50, further comprising providing an
2 enable bit to a register from an external operating system to activate the thermal
3 management system.

1 53. (Withdrawn) The method of claim 50, further comprising:
2 incrementing an up-down counter coupled with the sensor output once for every clock
3 pulse of a clock signal provided by internal clock circuitry on the die when the
4 sensor output exhibits the first state; and
5 decrementing the up-down counter once for every clock pulse of the clock signal
6 provided by the internal clock circuitry when the sensor output exhibits the second state.

1 54. (Withdrawn) The method of claim 50, further comprising:
2 defining a plurality of trip temperatures, a highest of the plurality of trip temperatures
3 corresponding to the trip point;
4 assigning a plurality of duty cycle values to the plurality of trip temperatures, one duty
5 cycle value of the plurality of duty cycle values corresponding to at least one of
6 the plurality of trip temperatures; and
7 providing a clock signal from internal clock circuitry on the die, the clock signal
8 exhibiting the one duty cycle value in response to the temperature substantially
9 equaling the at least one corresponding trip temperature.

1 55. (Withdrawn) The method of claim 50, further comprising counting a
2 number of lost clock cycles resulting from engagement of the power reduction
3 mechanism.

1 56. (Withdrawn) The method of claim 50, further comprising providing an
2 indication of a status of the sensor output to an external device.

1 57. (Withdrawn) A method comprising:
2 activating a thermal management system of a die;
3 measuring a temperature on the die with a sensor of the thermal management system;
4 providing a first state at an output of the sensor when the temperature is below a trip
5 point;
6 providing a second state at the sensor output when the temperature equals or exceeds the
7 trip point;
8 engaging a power reduction mechanism in response to the sensor output having the
9 second state;
10 providing the first state at the sensor output when the temperature is below an untrip
11 point, the untrip point less than the trip point; and
12 halting the power reduction mechanism in response to the first state.

1 58. (Withdrawn) The method of claim 57, further comprising engaging the
2 power reduction mechanism to perform at least one of lowering a supply voltage to the
3 die, lowering a frequency of a clock signal provided by internal clock circuitry on the die,
4 performing clock gating of the clock signal provided by the internal clock circuitry,
5 performing clock throttling of the clock signal provided by the internal clock circuitry,
6 selectively blocking clock pulses of the clock signal provided by the internal clock
7 circuitry, disabling at least one of a plurality of functional units on the die, limiting
8 instructions sent to at least one of the plurality of functional units on the die, and
9 changing a behavior of at least one of the plurality of functional units on the die.

1 59. (Withdrawn) The method of claim 57, further comprising providing an
2 enable bit to a register from an external operating system to activate the thermal
3 management system.

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1 60. (Withdrawn) The method of claim 57, further comprising:
2 incrementing an up-down counter coupled with the sensor output once for every clock
3 pulse of a clock signal provided by internal clock circuitry on the die when the
4 sensor output exhibits the first state; and
5 decrementing the up-down counter once for every clock pulse of the clock signal
6 provided by the internal clock circuitry when the sensor output exhibits the
7 second state.

1 61. (Withdrawn) The method of claim 57, further comprising:
2 defining a plurality of trip temperatures, a highest of the plurality of trip temperatures
3 corresponding to the trip point;
4 assigning a plurality of duty cycle values to the plurality of trip temperatures, one duty
5 cycle value of the plurality of duty cycle values corresponding to at least one of
6 the plurality of trip temperatures; and
7 providing a clock signal from internal clock circuitry on the die, the clock signal
8 exhibiting the one duty cycle value in response to the temperature substantially
9 equaling the at least one corresponding trip temperature.

1 62. (Withdrawn) The method of claim 57, further comprising counting a
2 number of lost clock cycles resulting from engagement of the power reduction
3 mechanism.

1 63. (Withdrawn) The method of claim 57, further comprising providing an
2 indication of a status of the sensor output to an external device.